

4500

Berkeley, California
December 18, 1963

BMNR
FEB 24 1964 342.4
Circulation day
1964
2041

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Progress Report

TESTS FOR CONTROL OF THE PINE REPRODUCTION WEEVIL

STANISLAUS NATIONAL FOREST, CALIFORNIA-1962

By

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NOT FOR PUBLICATION

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION

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U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION
Forest Insect Research

TESTS FOR CONTROL OF THE PINE REPRODUCTION WEEVIL

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By

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SUMMARY

In a number of recent instances, spraying to prevent damage to planted ponderosa and Jeffrey pines by the pine reproduction weevil has been generally unsuccessful. To explore the possible cause or causes of these failures, spray tests were carried out on the Stanislaus National Forest in June 1962. These tests were aimed primarily at determining if the standard control method (an aerial spray of 1 pound of DDT in 1 gallon of diesel oil per acre) would work when carefully applied, and if not, why.

The tests consisted of three applications of DDT spray applied by helicopter, and a single hand application. All were field tests, and the spray in each instance was applied to the adult stage of the weevil in order to prevent oviposition. This, similarly, is a feature of the recommended control method.

The aerial tests utilized the standard spray formulation, applied at rates of 1 and 2 gallons per acre, and a $\frac{1}{2}$ -pound DDT per gallon formulation, applied at the rate of 2 gallons per acre. The hand application utilized the 1 pound in 1 gallon formulation.

The results of the aerial applications were generally inconclusive; several factors contributed to a rather low spray recovery, and stand and infestation conditions may have obscured treatment effects. The hand application, while of a limited nature, was apparently successful in preventing attacks.

AERIAL SPRAY TESTS

INTRODUCTION

The pine reproduction weevil, Cylindrocopturus eatoni Buchanan, has attracted the attention of California foresters and forest entomologists since the 1930's. It has been responsible for large-scale losses in ponderosa and Jeffrey pine plantations, and is also found killing natural reproduction (Eaton 1942; Miller 1950). Early brush-field plantings (Dunning and Kirk 1939) were often devastated by weevil attack.

Following World War II a control method was devised employing either aerial or ground spray applications of DDT, at the rate of 1 pound in 1 gallon of diesel oil per acre (Hall 1948). While admittedly of a temporary nature, this treatment appeared to be effective in protecting trees from attack for up to three seasons (Miller 1950). In recent years, however, control failures have been more common than successes (table 1).

Table 1.--Summary of Forest Service pine reproduction weevil control projects, 1957-1961^{1/}

National Forest	Year	Area	Control method	Acreage	Evaluation of results
Eldorado	1957	Toni Gulch	Pull-burn	10	Unsuccessful
"	1958	" "	Helicopter	10	"
"	1959	" "	Hand spray	10	Successful
"	1959	5-Corners	" "	18	"
Stanislaus	1958	Spinning Wheel	Helicopter	265	Unsuccessful
"	1959	" "	Airplane	1,550	"
"	1959	" "	Hand spray	40	"
"	1959	Basin Creek	Airplane	500	"
"	1960	" "	Helicopter	265	"
"	1961	" "	Pull-burn	490	"
"	1961	Spinning Wheel	Helicopter	1,200	"

^{1/} Data furnished by Division of Timber Management, U. S. Forest Service, San Francisco, California.

Unfortunately the criteria for evaluating the degree of success of these operations have not been standardized, so we cannot consider the evaluations strictly comparable. However, all presumably were made on the basis of numbers of trees apparently killed by weevils in the years just prior to treatment compared with the years just following.

Entomological observations in most of these more recent control operations have been of a limited nature, and detailed reports have not been prepared. Consequently, in most of the instances the reason or reasons behind the failure of the method to control the weevil can only be guessed at. Among the possibilities that have been suggested are the weevil's development of resistance, variation in the habits of the weevil in different portions of its range, and improper timing and application of the treatment.

In order to learn more about the efficacy of DDT for controlling the insect, field tests were conducted in June 1962 on the Spinning Wheel plantations northeast of Groveland on the Stanislaus National Forest. These ponderosa pine plantations had suffered heavy losses attributed to weevils. The objectives of the tests were to determine if the standard control method would work when carefully carried out, and to test two other DDT formulations utilizing greater volumes of material.

The tests were a combined effort of the Pacific Southwest Forest and Range Experiment Station, and the California Region, U. S. Forest Service. The Station, in the person of the writer, developed the plans and handled the entomological phases of the work and evaluated the results, while the Region arranged for the operational phases of the work. This report covers only the Station's part of the job; the operational phases have already been reported (Swain 1962).

AREAS AND TREATMENTS

Four treatment blocks were selected at the Spinning Wheel plantations (fig. 1). These plantations were established around 1955, and the stands in 1962 were highly variable with respect to density, brush competition, and reproduction weevil activity. In some places only widely scattered trees remained alive. The trees in the better locations were from 6 to 10 feet tall; in the poorer locations the trees remaining alive were badly stunted and were often under 2 feet tall. The planted trees are essentially all ponderosa pines. The elevation in the plantations is in the three-to four-thousand-foot range.

Spray blocks were picked insofar as possible in areas having a fair amount of current weevil activity and also having enough remaining trees to reflect success or failure of control. Care was taken to obtain adequate separation of the blocks to prevent contamination through spray drift. Fulfilling all these requirements proved to be a difficult task.

The insecticide used was a commercial formulation of DDT in an auxiliary solvent and diesel oil and was applied by helicopter. Spray block sizes and treatments were as follows:

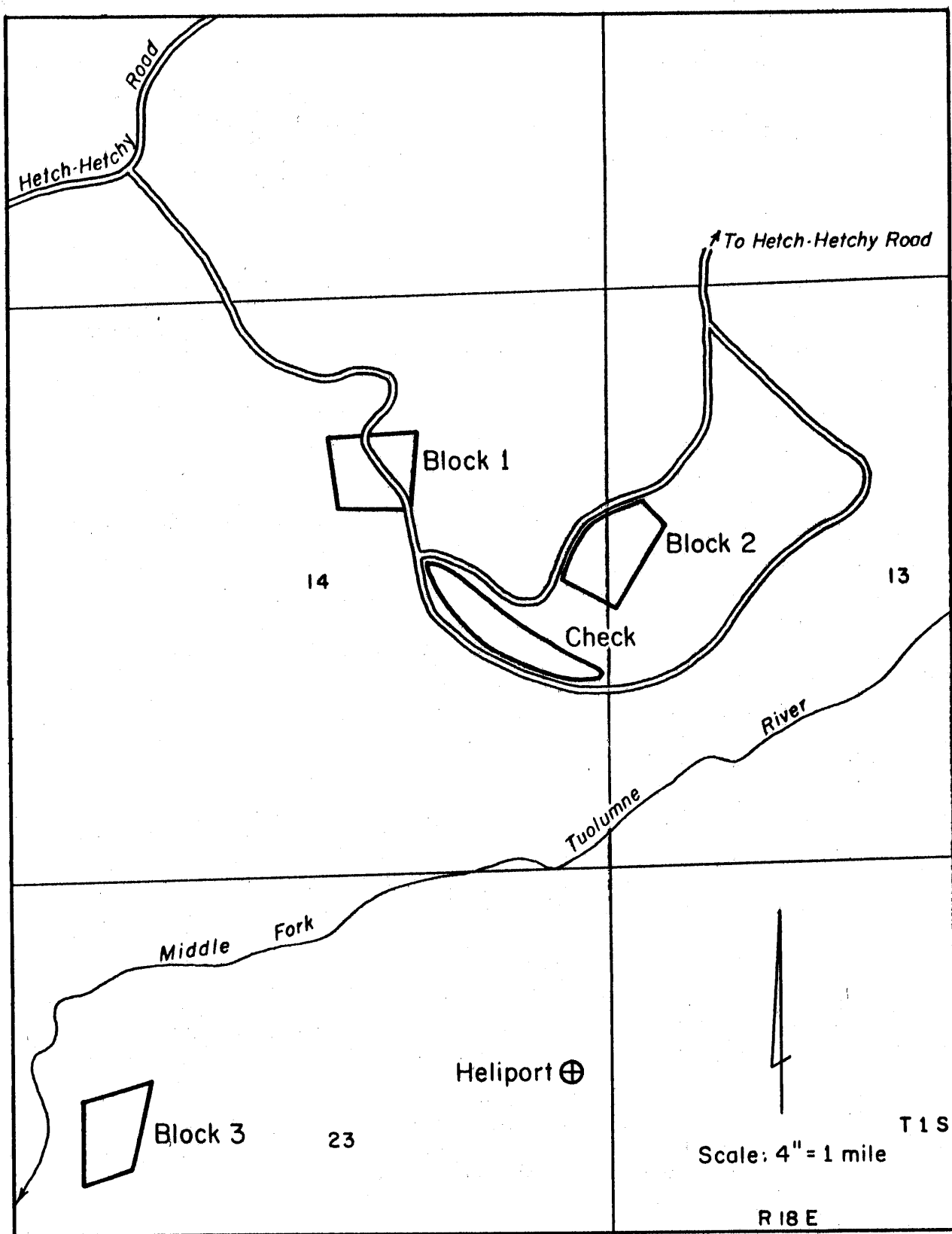


Figure 1.--Spray block locations. Spinning Wheel pine reproduction weevil spray tests, Stanislaus National Forest, 1962.

<u>Block</u>	<u>Acreage</u>	<u>Treatment</u>
1	11	2 lbs. DDT/2 gals. oil/acre
2	15	1 lb. DDT/2 gals. oil/acre
3	13	1 lb. DDT/1 gal. oil/acre
Check	20	Unsprayed

TIMING

Three weeks after initial emergence of the adults in the spring has been considered the optimum time to apply spray for reproduction weevil control (Hall 1957). Periodic checks on weevil development were started in late May to determine when this date would fall.

Data were gathered by periodically dissecting portions of stems from five or six infested trees collected from each spray block until 100 insects were accounted for. The insects were identified as larvae, pupae, or adults; abandoned pupal cells and associated emergence holes were considered emerged adults. Emergence was well under way when the observations were begun (table 2), but emergence was subsequently followed until all samples indicated no further insects remaining in the material. On the basis of the earliest observations it was estimated that June 8 would be the proper date for the spray to be applied. The work was done as scheduled on June 8.

MEASURING THE EFFECTS OF SPRAYING

Damage Reduction

To measure damage reduction, a series of 25 1/40-acre circular plots was established in June in each spray block and the check block. The plots were located at approximately 2-chain intervals along lines passing through portions of the blocks having the heaviest 1961 weevil-caused losses. The trees in each plot were marked with paint for subsequent identification in the postcontrol survey. The number and character of infested (1961-62 generation) trees and cause of death were recorded, along with the number of green trees (table 3).

Number of Insects

To get some ideas about the number of weevils present on the spray blocks following treatment, and on number of weevils succumbing to the insecticide, two censusing techniques were employed. Beatings were conducted, and in addition paper cones (Hall 1948) were constructed to catch dying beetles falling out of trees.

One tree on each of the 1/40-acre plots was marked and beaten at intervals following the spray application. The beating technique involved holding an insect net under individual branches and striking the branches sharply with a stick. The weevils are somewhat inclined to cling to the

Table 2.--Brood development in spray blocks, Spinning Wheel tests, 1962

Date	Percent of population				Date	Percent of population			
	Larvae	Pupae	Adults	Emerged adults		Larvae	Pupae	Adults	Emerged adults
<u>Block 1</u>					<u>Block 2</u>				
5-30	0	30	51	19	5-24	2	75	19	4
6-8	0	2	12	86	5-31	0	62	25	13
6-12	0	0	15	85	6-8	0	25	52	23
6-15	0	0	19	81	6-12	0	7	26	67
6-27	0	0	0	100	6-15	0	0	21	79
					6-26	0	0	2	98
					7-2	0	0	0	100
<u>Block 3</u>					<u>Check</u>				
5-23	0	47	41	12	6-5	0	16	63	21
5-29	2	26	47	25	6-8	0	2	48	50
5-31	0	15	46	39	6-12	0	0	21	79
6-5	0	3	40	57	6-14	0	1	18	81
6-8	0	7	23	70	6-27	0	0	0	100
6-11	0	1	12	87					
6-14	0	0	8	93					
6-20	0	0	0	100					

Table 3.--Condition of trees in sample plots before spraying, Spinning Wheel spray tests, 1962

Block	Total	Green	Currently infested by weevils		Dead, cause
	trees		Dead	Damaged	unknown
<hr/>					
<div>----- <u>Percent of stand</u> -----</div>					
1	243	86.4	6.6	2.5	4.5
2	254	70.8	19.7	5.9	3.6
3	237	85.6	8.4	3.4	2.5
Check	189	83.0	13.8	2.6	0.5

branches, and this technique did not result in appreciable numbers being disturbed and flying away. Smaller trees were beaten as a unit into the net. The weevils were picked from the net, counted, and returned to the tree.

Paper cones were installed underneath two other trees in each block, and collections were made from them generally at the same time that the beatings were conducted.

Spray Coverage

Oil-sensitive cards were laid out in each of the 1/40-acre plots at the time of spraying. Spray recovery on these cards was subsequently evaluated by comparison with standards.

RESULTS AND DISCUSSION

Only one of the applications provided any worthwhile reduction over the previous years' losses, and even in this instance nearly 5 percent of the trees died (table 4).

Table 4.--Trees infested by weevils before and after treatment,
Spinning Wheel spray tests, 1962

Block :	Treatment :	Infested trees 1962 : (prespray)	Infested trees 1963 : (postspray)
- - - - - Percent of stand - - - - -			
1	2 lbs./2 gal./acre	6.6	6.2
2	1 lb./2 gal./acre	19.7	4.4
3	1 lb./1 gal./acre	8.4	7.8
Check	Unsprayed	13.8	8.7

The number of insects beaten from the selected trees remained relatively stable for each block throughout the period this activity was carried out, but far fewer insects were present in blocks 1 and 3 than in block 2 and the unsprayed check (table 5).

Table 5.--Weevils beaten from selected trees,
Spinning Wheel spray tests, 1962

Spray block	Week of							
	6/10	6/17	6/24	7/1	7/8	7/15	7/22	7/29
1	2	4	17	16	--	--	--	--
2	61	99	135	166	116	104	--	--
3	26	26	15	24	8	--	--	--
Check	254	387	330	285	147	110	--	60

With the exception of block 2, the paper cones produced only a few weevils.

<u>Spray block</u>	<u>Total weevils collected in cones</u>
1	4
2	63
3	4
Check	9

Spray recovery in each instance was approximately 25 percent of the amount applied (table 6).

Table 6.--Estimates of spray recovery on oil-sensitive cards,
Spinning Wheel spray tests, 1962

	<u>Spray block</u>			Check
	1	2	3	
Number cards exposed	25	25	20	25
Dosage (gals./acre)	2.0	2.0	1.0	0
Mean spray recovery (gals./acre)	0.5	0.5	0.24	0
DDT concentration (lbs./gal.)	1.0	0.5	1.0	0
Mean DDT recovery (lbs./acre)	0.5	0.25	0.24	0

The results measured in percent of stand killed by weevils in 1962-63 were inconclusive. Only on block 2 was a meaningful reduction obtained, from 19.7 percent killed in 1961-62 to 4.4 percent killed in 1962-63. Losses on blocks 1 and 3 remained essentially unchanged, and a reduction in loss was noted in the unsprayed check.

Numbers of weevils beaten from the trees (table 5) did not correlate with damage. While the unsprayed check produced many more weevils than did the other blocks, losses there declined.

The spray recovery (table 6) was generally low, and it also did not correlate with the loss reduction on the different blocks. One could surmise from the damage reduction data that the treatment applied to block 2 was somewhat effective. Even in this instance, however, nearly 4 percent of the residual stand was lost.

Some of the reason for our lack of clear-cut results probably lies in the relatively poor spray recovery. Possible causes for this included a helicopter pilot inexperienced in this type of work, a formidable overstory of scattered snags forcing the pilot to hold the aircraft well over 100 feet from the ground, and marginal wind conditions on the day of spraying. An improvement in any of these factors might have been expected to result in better spray recovery.

The general "vigor" of the trees presumably has an important effect on their ability to resist weevil attacks. With trees growing under adverse conditions, it is possible that a relatively few weevils could cause mortality.

Adverse growing conditions alone may sometimes cause trees to die. In the precontrol survey a number of dead trees were found that had not been infested by insects (table 3). Station pathologists were unable to locate disease organisms that could be incriminated as the cause of mortality. Thus the death of these trees must tentatively be ascribed to the effects of the physical environment alone.

These plantations are quite extensive, and clearly occupy sites of varying quality. In some locations within the planted area large stumps attest to a history of productive stands of ponderosa pine. Digger pines and oaks have occupied some areas, however, indicating that the site is not uniformly good.

Many of the trees that were killed in the plantations were either improperly planted or deformed during their existence in the nursery. This is evidenced by their roots being bent sharply upward in the shape of a "J." While in time this deformity has been somewhat outgrown, it presumably detracts from the tree's ability to overcome adverse conditions.

It was soon noted in the course of the work that many of the dying trees were concurrently infested with the Yosemite bark weevil, Pissodes yosemite Hopkins. Of the trees dying in block 3 in 1962, 65 percent also contained Pissodes. This, then, was a combined attack by the two weevil species, and not simply a Cylindrocopturus infestation as had been previously believed. How much Pissodes contributes quantitatively to the death of a tree attacked by both weevil species is not known. However, dead trees have since been found that were infested with Pissodes alone.

HAND SPRAY TEST

A small group of trees occupying about one-fourth acre near aerial spray block 2 was sprayed with a compressed-air type hand sprayer on June 19. The formulation used was the 1 pound DDT per gallon of diesel oil mixture, and this material was applied at a rate estimated at between 5 and 10 gallons per acre.

The group consisted of 12 green trees, 12 trees killed in 1961, and 5 killed 1 or 2 years earlier. The group was somewhat isolated from the rest of the stand, and trees averaged about 5 feet tall. Brush competition was severe; there was no bare ground.

The weevil population in the trees was sampled by beating prior to spraying, and this work yielded an average of 15 weevils per tree, with a range of 6 to 45. At the time of spraying, emergence from the trees killed in 1961 was approximately 80 percent complete. Numerous feeding punctures were present on the needles, but no punctures were detected on the stems or branches.

On June 2, about 2 weeks after the trees were sprayed, they were once again sampled for weevils. Only one weevil was recovered. Subsequent visual inspections through mid-July did not disclose any further weevil activity on the treated trees, but elsewhere nearby weevils remained active until well into July (table 5). None of the green trees in this test was killed by weevils in 1962. The results of this limited experiment indicate that the number of weevils can be reduced and the trees protected for at least one season by a DDT treatment of the type used.

CONCLUSIONS

The aerial spray treatments of DDT as reported here failed to give satisfactory protection against weevil attack. Hand spraying, however, did appear to offer good protection for at least one season. This indicates that DDT remains effective, and that spray coverage is of prime importance in achieving control of this sort.

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